Gold and Silver Investment in India: an Investor's Perspective

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Abstract: Gold and silver are valued for their aesthetic characteristics as well as being excellent investment avenue. In light of the Indian financial market, it is important to understand their portfolio and hedging capabilities. Thus, the objective of this study is to explore the potential benefits of investing in gold and silver, with a focus on how they might be used as hedging strategies against inflation and market volatility. We aim to investigate the time-varying relationships among inflation, gold, silver, and the Nifty index, spanning from November 2003 to March 2023. This will provide insight into the dynamic interdependence of different financial assets and how that impacts portfolio management strategies. We use the Generalized Autoregressive Conditional Heteroskedasticity (GARCH)-Dynamic Conditional Correlation (DCC) model to achieve our objectives. Using this methodology, we can examine the relationships throughout time between the Nifty index, inflation, gold, and silver while accounting for the volatility in the market during the COVID-19 epidemic and the 2008 financial crisis. We discovered a statistically significant positive correlation between silver and inflation, indicating that silver is useful to hedge inflation. Comparing to gold, silver is an excellent hedge against inflation. Additionally, during the financial crisis period there is a significant negative correlation between the Nifty index and gold, indicating that gold may be utilized as a hedge against stock market declines. The findings of the research have major implications for hedging tactics and portfolio management in the Indian financial market. Although gold has characteristics that may make it an inflation hedge, there is no evidence of long-term importance in its link with the Nifty index. Still, there might be advantages in terms of lower risk when gold and the Nifty are combined in a diversified portfolio. Gold's importance as a safe-haven asset is highlighted by the dynamic nature of correlations, especially during market downturns, as seen by its performance during the 2008 financial crisis.

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1. Introduction

Gold, one of the earliest precious metals to be discovered by mankind, has long been used as a store of value, a fashionable ornament, and a form of money. It served as a means of trade and a repository for riches back then. It still serves as a significant store of value, particularly in difficult times. Gold's tangibility distinguishes it from paper asset classes like stocks and bonds (Sumner et al 2010). Investors seek out gold for a variety of reasons, such as diversification, inflation safeguards, store of value, they buy gold as a hedge against any economic, political, or currency crises (Wang et al, 2011). According to Jaffe (1989), gold could provide diversification advantages due to the likelihood of its price changes being distinct from those of ordinary stocks. Hillier et al (2006) noted that precious metals provide significant diversifying benefits in volatile markets when held in a portfolio. Silver is a priceless metal that has been used for a wide range of purposes, including jewellery, coinage, and industrial applications. Silver is a different precious metal that has drawn interest from investors as a potential investment.

It is important to consider the Indian economy's rapid growth when evaluating gold and silver's potential to protect against inflation and volatile stock markets. India's economy has grown enormously, and this trend is seen in the country's demand for gold. The World Gold Council (2021) found a close correlation between India's demand for gold and income growth, with a one percent increase in income often translating into a one percent increase in gold demand.

Gold is considered by investors as a safe-haven asset that is in great demand during volatile markets or uncertain economic times (Pradeep. K. V and Karunakaran N, 2021, 2022). Investors use gold as a commodity to diversify their assets and hedge against inflationary pressures. Even while silver might not have the same qualities as gold, it is nevertheless valued as a precious metal and can offer similar protection against downward economic trends. This article uses data on gold futures from the Multi Commodity Exchange India (MCX) to examine these trends and dynamics. Through gold futures contracts, investors can make predictions about the price of gold in the future, giving them insight into the expectations and sentiment of the market

2. Literature Review

The correlation between gold prices and inflation has been studied by a number of academics. The ability of gold prices to hold their value in the face of inflation becomes crucial from the standpoint of an investor. Investors have traditionally considered gold and gold equities to be effective inflation hedges (Chua et al, 1990). The method through which inflation affects gold prices is described by Fortune (1987). He claims that future inflation and interest rates determine how much the price of gold will rise. Liquid assets' actual value will decline when expected future price increases happen. As a result, people will be motivated to transfer their liquid assets into gold. As a result, the value of gold in that currency increases, so protecting its users from the effects of inflation. Wang et al. (2011) examined the effectiveness of gold as a short- and long-term inflation hedge in the United States and Japan. They discovered that gold returns do not function as an inflation hedge during the low momentum regimes in both nations. While it does not completely hedge against inflation in the near run, it is possible to guard against inflation during high momentum regimes in the US. Hoang et al (2016) used a nonlinear autoregressive distributed lags (NARDL) model on monthly gold price data from China, India, Japan, France, the United Kingdom, and the United States to investigate gold's inflation hedging role. They discovered that gold has a temporal and region-specific hedging capacity; gold is not a long-term inflation hedge. In the short run, gold is merely an inflation hedge in the three countries studied, namely the United Kingdom, the United States, and India. They also discovered that in China, India, and France, there is no long-run equilibrium between gold prices and the CPI. The studies by Artigas (2010), Shahbaz et al. (2014), Bampinas and Panagiotidis (2015) supports gold are ability to hedge against inflation. In both the short- and long-run, gold and silver is reliable hedge against inflation (Adrangi et al 2003)

Many studies show that gold can be a beneficial investment option, especially in volatile markets (e.g., Baur and McDermott, 2010; & Mensi et al 2013). Gold is a safe haven investment. Investors want safe haven assets to secure their cash during periods of uncertainty (Lucey and Ley 2014). Gold can be used as a safe haven in the event of any economic, political, or currency crisis (Wang et al, 2011). Hillier et al (2006) noted that precious metals provide significant diversifying benefits in volatile markets when held in a portfolio. Mensi. W et al. (2013) looked into the dynamic correlation between stock indexes and commodity future returns. They found that because gold and silver have a negative correlation with Saudi Arabian stock returns, they can be used to manage risk.

Similar to gold, silver may be utilised for a variety of purposes in an investment portfolio.

Affordability, protection against inflation, and diversity are all included. Walid, et al (2015) looked at the linkages between the Saudi Arabian stock market and the major commodity futures markets, including gold, silver, oil, maze and rice. They found strong evidence for the benefits of diversification, the effectiveness of hedging, and the reduction of downside risk.(Bhatia et al., 2020) studied the dynamic relationship between the stock markets and precious metals in developed and emerging nations. They noticed that the precious metals return series and the stock market changed over time. They also found that compared to other precious metals, silver provides stronger long- and short-term hedging potential. The study of Gençyürek & Ekinci (2023) on the use of precious metals in risk management is extensive. Through empirical research, the paper presents significant insights into how well precious metals perform in the BRICS-T equities markets as risk management techniques. They stated that metals, like silver, may provide advantageous diversification and serve as safe-haven assets during periods of market instability. (Alqaralleh & Canepa, 2022) examined how the initial Covid-19 epidemic affected the stock market and the price of precious metals. They found that precious metals offer potential benefits for market diversification. With regard to short, medium and long-term investment perspectives, all metals, including silver, serve as safe-haven assets.

Research specifically looking at the dynamics of investments in gold and silver within the framework of the Indian financial sector is negligible (Hani Ahammed, Sanushma. S, and Karunakaran N, 2024). Given India's distinct economic environment and status as an emerging market, it is critical to understand how gold and silver function in this market as safe-haven investments and inflation hedges. While some study has examined the impact of economic crises on gold and silver, further investigation is necessary to understand the behaviour of these assets in the Indian context during the COVID-19 pandemic and the 2008 financial crisis. These events may have had a substantial effect on investor behaviour, market dynamics, and the performance of gold and silver as Investment Avenue in India. Investors and policy makers looking to effectively manage inflation risk need to understand the short- and long-term inflation hedging potential of gold and silver in India.

3. Materials and Methods

Our data set consists of monthly time series for futures gold prices, futures silver, nifty index and the Wholesale price index. Instead of using the Consumer Price Index to calculate inflation, we used the Wholesale Price Index. The Consumer Price Index (CPI) is computed differently in India for several groups, including the CPI for Industrial Workers (CPI-IW),

CPI for Agricultural Labourers (CPI-AL), and CPI for Rural Labourers (CPI-RL).The CPI Combined is a more comprehensive indicator that takes into consideration the prices of the goods and services that households in both urban and rural regions use.The CPI Combined index was introduced in India in January 2011. Prior to this, the CPIs for urban and rural regions were calculated separately. As our study period covers 2003 to 2023, we used the whole sale price index to calculate inflation. The monthly frequency is used because only monthly data available for the Wholesale Price Index (WPI). Gold futures prices and Silver futures prices are collected from the website of MCX. Nifty data collected from the website of NSE. WPI is collected from the website of Office of Economic Advisor. Our research spans the years December 2003 through March 2023. As a result, it covers both the 2008 financial crisis and the recent Covid-19 pandemic period. Thus, we can evaluate gold's performance during these periods.

To calculate return series, we used the following formula.

$$r_t = \ln\frac{X_t}{X_{t-1}}\ \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots. (1)$$

Where, X_t is the closing price of future gold, futures silver price, and stock market index

3.1. Unit Root Test: Stationarity of the series is very important in the time series analysis, otherwise it will produce spurious result. Data is said to be stationary when the value of a time series data reverts to its long-run average value and the qualities of the data are not influenced by changes in time alone.

We used the most popular methods of unit root test, Augmented Dickey Fuller test and Philips Perron test.

3.1.1. Augmented Dickey-Fuller (ADF) Test: The ADF test examines the null hypothesis that a unit root is present in a time series against the alternative hypothesis of stationarity. The ADF test regression equation is:

$$\Delta y_t = \alpha + \beta t + \gamma y_{t-1} + \delta_1 \Delta y_{t-1} + \delta_2 \Delta y_{t-2} + \cdots + \delta_p \Delta y_{t-p} + \varepsilon_t\ \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots$$
(2)

Where: Δy_t is the differenced time series at time t, α is the intercept, βt captures any linear trend in the data, γy_{t-1} represents the coefficient of the lagged dependent variable, $\delta_i \Delta y_{t-i}$ are coefficients of the lagged differenced series, and ε_t is the error term.

3.1.2. Phillips-Perron (PP) Test: The PP test is similar to the ADF test but accounts for both serial correlation and heteroskedasticity. The PP test regression equation is:

$$\Delta y_t = \alpha + \beta t + \gamma y_{t-1} + \delta_1 \Delta u_{t-1} + \delta_2 \Delta u_{t-2} + \cdots + \delta_p \Delta u_{t-p} + \varepsilon_t\ \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots..(3)$$

Where: Δu_t represents the residuals from the regression. All other variables are the same as in the ADF test.

3.2. DCC-GARCH: Engle (2012) developed a DCC-GARCH model that extracts time varying correlations between distinct variables using dynamic correlation coefficients. It allows for the inference of time-varying correlations between variables directly. The DCC follows a two-step process. First, we fit Bollerslev's (1986) GARCH (1, 1) model, which allows us to minimise the number of estimated parameters by imposing non-linear constraints. The mean and variance equation for GARCH (1, 1) is as follows:

$$Y_t = \phi + \varepsilon_t \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots(4)$$
$$h_t = \omega + \alpha\varepsilon_{t-1}^2 + \beta h_{t-1}\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots(5)$$

The mean equation is a function of constant and standardised residual. The variance equation is made up of a constant component, a squared lagged residual from the mean equation to indicate prior period volatility, and anticipated variance from the previous period. The second step is to construct DCC model on the study variables. The conditional variance covariance matrix can be represented as

$$\varepsilon_{i,t}/I_{t-1} \sim N(0, H_t), H_t = \begin{bmatrix} \sigma_{i,t}^2 & \sigma_{ij,t}^2 \\ \sigma_{ji,t}^2 & \sigma_{j,t}^2 \end{bmatrix}$$

Let us take INF and FG as an example

$$H_t = \begin{bmatrix} h_t^{INFINF} & h_t^{INFFG} \\ h_t^{FGINF} & h_t^{FGFG} \end{bmatrix} \text{s}$$

Where $\varepsilon_{i,t}$ is the (2×1) vector of residuals derived by the VAR model, and I_{t-1} is the rest of the data set accessible up to that point (t-1). The variance–covariance matrix of residuals in a two-variable context is given as

$$H_t = D_t R_t D_t \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (6)$$

Where D_t is a diagonal matrix of size 2 by 2 of the time-varying standard deviations produced by univariate GARCH (1,1) and H_t is the conditional variance-covariance matrix of size 2 by 2 at time t; R_t is the time-varying correlation matrix of size 2 by 2 at time t

$$h_t = \phi + \alpha\varepsilon_{t-1}^2 + \beta h_{t-1}\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (7)$$

The conditional covariance terms are then assumed to follow the DCC (1, 1) specification

$$\begin{aligned} h_{ij,t} &= \rho_{ij,t}\sqrt{h_{ii,t}}\sqrt{h_{ij,t}} \\ \rho_{ij,t} &= \frac{q_{ij,t}}{\sqrt{q_{ii,t}}\sqrt{q_{jj,t}}} \text{ and} \quad\quad\quad\quad \dots\dots\dots\dots\dots(8) \\ q_{ij,t} &= \bar{\rho}_{ij}(1 - a - b) + aq_{ij,t-1} + b\eta_{i,t-1}\eta_{j,t-1} \end{aligned}$$

Where, $q_{ij,t}$ is the conditional covariance between standardised residuals $\left(\eta_{i,t-1} = \varepsilon_{i,t}/\sqrt{h_{ii,t}}\right)$ from Equation (4). $\rho_{ij,t}$ is the unconditional correlation between model residuals (ε_{it}).The average variance of qij,t will be 1, and the average variance of $q_{ij,t}$ will be $\bar{\rho}_{ij}$. When a + b <1, the qij,t expression will mean-revert. The specification lowers down on the number of parameters that must be calculated.

A two-stage method to maximise the log-likelihood function can be used to estimate the DCC model.

$$\left[-\frac{1}{2}\sum_{t=1}^{T}\left(n\log(2\pi) + \log|D_t|^2 + \varepsilon_t^{'}D^{-2}\varepsilon_t\right)\right] +$$

$$\left[-\frac{1}{2}\sum_{t=1}^{T}\left(\log(2\pi) + \log|R_t| + \mu_t^{'}R_t^{-1}\mu_t - \mu_t^{'}\mu_t\right)\right]$$

In the first stage, the log-likelihood function can be maximised over the parameter in Dt. Utilising the calculated parameters from the first step, the correlation component of the likelihood function may be maximised in the second stage to estimate correlation coefficients..

4. Results, Analysis and Discussion

This section contains the findings of our research on the viability of gold and silver as investment assets, including their potential to act as inflation hedges. We also give a thorough explanation of the results of our research and how investors might benefit from it. For investors and other market participants, the plots of these variables offer important insights into their trends, connections, and implications. We hope to shed insight on these key financial indicators' behaviour under various market conditions.

Figure 1: Plots of futures gold price, futures Silver and stock price

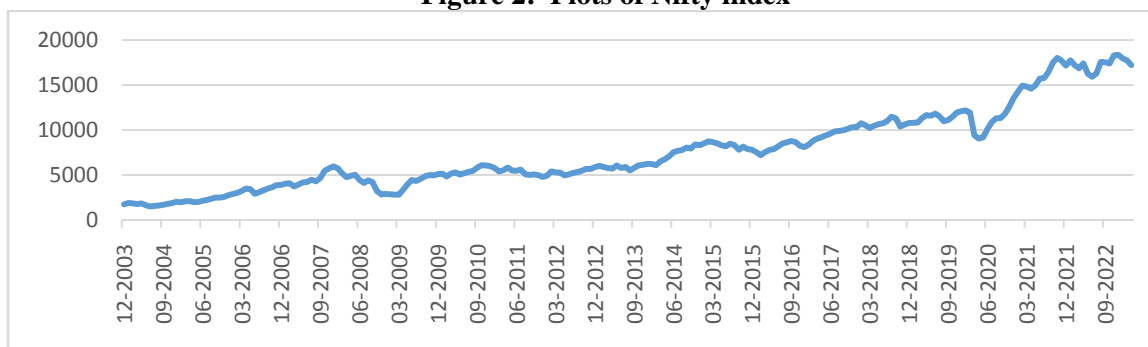
Source: Authors' calculation

The figure 1 shows how the price of gold and silver varies over time, increasing and decreasing at various points. Gold price is affected by a number of factors, including the status of the global economy, geopolitical events, and supply and demand dynamics. As a result, the price of gold is prone to sharp fluctuations and might be quite volatile. The COVID-19 epidemic and the 2008 global financial crisis were only a couple of the trends and occurrences that happened throughout the research period and had an effect on the price of gold.2013 saw a huge drop in the price of gold, which the strengthening US economy may be partly responsible for. In contrast, a variety of factors resulted in a significant increase in the price of gold in 2019. One of the primary reasons for this growth was the Federal Reserve's accommodative monetary policy, which lowered interest rates and raised the attractiveness of gold as an investment. Concerns over trade between the world's two major economies, the US and China, have led investors to turn to gold as a safe haven asset. The price of the precious metal was also driven higher by central banks' desire for it, especially those in China and India. Indian investors had to pay more for gold as a result of the rupee's declining value against the US dollar, which also raised demand for the precious metal. Investors quickly turned to safe-haven assets like gold as a result of the coronavirus pandemic's widespread fear and market volatility in 2020. Due to the low interest rate environment that central banks created to support their economies throughout the pandemic, gold became more attractive as an investment. These resulted in the rise in price of gold.

From 2003 to 2006, the price of silver barely rose compared to earlier years. In 2013, the price of silver fell by the most. Compared to gold, silver is more volatile. Silver's price fell as a result of a sluggish worldwide trend and little demand. 2015 saw the lowest silver price ever. The cost of silver skyrocketed in 2019. The recovery of the manufacturing sector and considerable investment inflows were the primary causes of this high price. Silver's price increased in 2020 along with the price of gold; uncertainty around the corona virus epidemic and the weakening of the dollar. Because of the weakening dollar and the uncertainty surrounding the corona virus pandemic, the price of gold and silver increased. In terms of stock values, they rose steadily before dropping down during the financial crisis of 2008. It also declined in the early stages of the Covid-19 epidemic before continuing to rise in March 2020. Between November 2003 and December 2022, the Nifty index experienced volatility but mostly upward direction**.**

Figure 2: Plots of Nifty index

Source: Authors' calculation

Efficient portfolio diversification requires a thorough examination of the movements of the Nifty index. Investment plans are greatly impacted by the stock market, which also acts as an indicator of the condition of the economy. Between January 2005 and December 2007, there was an impressive rise in the Nifty index, which climbed from about 2000 points to about 6000 points. It is driven by strong economic growth, huge inflows foreign institutional investment, and positive market sentiment. During this period, a number of significant events and circumstances contributed to the upswing, such as the introduction of value-added tax, the decrease of corporate tax rates, and the major expansion of the telecom and IT industries.

The worldwide financial crisis that started in the US subprime mortgage market and expanded to the rest of the world caused the Nifty index to crash, from about 6000 points in January 2008 to about 2500 points in March 2009. Massive sell-offs, a lack of liquidity, a contraction in credit, a depreciating currency, and fears of a recession all hurt the index. Between March 2010 and November 2010, there was a strong recovery in the Nifty index, which was attributed to a combination of factors that promoted economic revitalization. A synchronized global economic recovery, wherein international markets regained momentum and provided a good backdrop for Indian shares, was a major factor supporting the rebound. The global downturn, the market turbulence driven by China, the Fed's rate hike, the disappointment of domestic earnings, the hardship in rural areas, and the stress on the banking sector all contributed to the decline in the Nifty index between March 2015 and February 2016. January 2017 saw a resurgence of the Nifty index. It was caused by a number of variables, including the improvement of corporate earnings, the resurgence of domestic demand, and the global economic recovery. The index was drastically lowered by the COVID-19 pandemic in 2020, reflecting the pandemic's effects on the Indian economy and global markets. January 2021 saw a sharp rise in the Nifty index. The COVID-19 pandemic's domestic and international recovery, the immunization campaign, the monetary and fiscal

stimulus, all contributed to its growth. The descriptive statistics for all return series are reported in table 1

Table 1: The Descriptive Statistics For All Return Series

A: PRE-FINANCIAL CRISIS PERIOD (12/2003 TO 12/2007)				
	INFLATION	GOLD	SILVER	NIFTY
MEAN	0.4342	0.0115	0.0171	0.0271
MEDIAN	0.3902	0.0119	0.0258	0.0430
MAXIMUM	1.9868	0.1072	0.2495	0.1578
MINIMUM	-0.7361	-0.1056	-0.2088	-0.1649
STD. DEV.	0.5483	0.0393	0.0683	0.0582
SKEWNESS	0.5696	-0.1571	-0.1302	-1.2114
KURTOSIS	0.7172	1.1802	3.8242	2.2465
B: FINANCIAL CRISIS PERIOD (01/2008 TO 03/2009)				
MEAN	0.3854	0.0262	0.0103	-0.0503
MEDIAN	0.2333	0.0354	0.0270	-0.0354
MAXIMUM	2.5786	0.0978	0.1463	0.0685
MINIMUM	-1.8913	-0.0970	-0.1744	-0.2703
STD. DEV.	1.2377	0.0542	0.0889	0.0842
SKEWNESS	-0.0607	-1.1351	-0.5651	-1.1633
KURTOSIS	-0.2565	0.8040	-0.4127	2.1388
C POST FINANCIAL CRISIS PERIOD (04/2009 TO 03/2023)				
MEAN	0.3882	0.0079	0.0066	0.0108
MEDIAN	0.3771	0.0096	0.0048	0.0162
MAXIMUM	2.4776	0.1362	0.2083	0.1815
MINIMUM	-1.7528	-0.0691	-0.1375	-0.2359
STD. DEV.	0.7875	0.0322	0.0580	0.0449
SKEWNESS	-0.2112	0.5993	0.5388	-0.5756
KURTOSIS	0.3630	1.8443	0.9015	6.1625
D- WHOLE PERIOD (12/2003 TO 03/2023)				
MEAN	0.39770	0.00985	0.00906	0.01030
MEDIAN	0.37715	0.01186	0.00738	0.01815
MAXIMUM	2.57857	0.13617	0.24954	0.18146
MINIMUM	-1.89125	-0.10558	-0.20879	-0.27033
STD. DEV.	0.77720	0.03565	0.06243	0.05377
SKEWNESS	-0.15129	0.20388	0.22065	-1.13781
KURTOSIS	0.65419	1.23568	1.47709	5.12458

Source: Author's calculation

Except for gold, every asset class exhibited mean returns that were generally higher during the pre-crisis period than they were during other periods. This suggests that average returns on investments were higher during this time period. Nifty, with a mean return of 0.0271, showed the highest average return among the assets examined. Silver was the second-best performing asset in terms of average returns, behind Nifty, with a mean return of 0.0171. Silver, which is often regarded as a precious metal that is comparable to gold, had

considerable volatility during the examined time but still showed potential as an investment. Significant volatility was indicated by Silver's highest standard deviation (0.068). Finally, based on average returns, Gold was the third-highest performing asset with a mean return of 0.0115. Although its mean return is somewhat lower than that of the Nifty and Silver, this doesn't invalidate the asset's usefulness as a tool for portfolio diversification. Throughout this period, there was negative skewness in the left-skewed Nifty, Gold, and silver distributions.

All return series exhibited lower mean returns during the financial crisis period than they did during other periods. Interestingly, Nifty had a negative mean return of -0.050, pointing to a stock market decline in which investors suffered losses. The extent of the market fail during the crisis is highlighted by this negative mean return. In contrast, Gold showed a very strong performer throughout this period of uncertainty, yielding a significantly higher mean return of 0.026. Gold's strength during market turmoil was probably aided by its status as a safe-haven asset. Investors usually choose gold as a store of value and a haven from turmoil in the markets. The higher mean return for Gold suggests that it did rather well and produced some positive returns despite the broader market decline. In comparison to the crisis period, the financial landscape showed a different picture throughout the post-crisis period. The Nifty index showed positive mean returns, indicating a broader economic recovery and a revival of investor confidence after the crisis. Nevertheless, despite being regarded as safe-haven investments, Gold and Silver had poorer mean returns throughout this time. Gold recorded a mean return of 0.0079, while Silver had a mean return of 0. 0066. As market circumstances stabilized and investors restored trust in riskier assets, there may have been a change in demand away from safe-haven assets. Comparing the pre-financial crisis period to the post-financial crisis time, the standard deviations are substantially lower. Silver (0.0580) has the highest standard deviation, followed by nifty (0.0449) and Gold (0.0322) The mean returns for whole period were generally lower than they were during the pre-crisis period. At 0.0107, NIFTY had the greatest mean return of all the series during the whole period. This indicates that, on average, the stock market performed fairly well for the whole time. Moving on to standard deviations, we observe that Silver has the highest value (0.0624), indicating more volatility across the whole period compared to the other series. Nifty ranks in second with a standard deviation of 0.0537, illustrating the market's inherent volatility. In contrast, Silver and Nifty showed higher volatility than Gold, which had the lowest standard deviation (0.356). When the skewness statistics are reviewed, Nifty displays negative skewness for the whole time. This shows that the distribution of returns for Nifty, which was skewed to the left, had more occurrences of lower returns. The positive skewness of Gold and Silver, on the other hand, indicates a distribution with a longer right tail and more instances of higher returns. The correlation coefficients between various asset returns are seen in table 2.

Table 2: Correlation Matrix

	GOLD	NIFTY	SILVER	INFLATION
GOLD	1.000000	-0.093208	0.711530	0.051024
NIFTY	-0.093208	1.000000	0.233899	0.050569
SILVER	0.711530	0.233899	1.000000	0.176441
INFLATION	0.051024	0.050569	0.176441	1.000000

Source: Author's calculation

All correlation coefficients are theoretically valid. There is a negative correlation between gold and the nifty. Given the negative correlation, it is possible that investors will use gold as a hedge or safe-haven investment during times of stock market declines. On the other hand, in a bull market, investors might prefer stocks, which would lower the price of gold. There is a positive correlation between gold and inflation. Given that gold and inflation have a positive correlation, rising inflationary pressures are generally accompanied by rising gold prices. As a result, during times of inflation, investors may turn to gold as a store of value and protection against the decline of purchasing power. Silver exhibits a positive correlation with Nifty. The fact that silver serves as both a precious metal and an industrial commodity may be the reason for this positive correlation. These correlations assume that there is a consistent and stable correlation between two variables. It is important to realize that, despite providing valuable insights into the relationships between different assets, correlations are not static and may vary over time. A wide range of factors, such as market dynamics, economic conditions, geopolitical events, and others, can cause asset correlations vary and fluctuate. Through the examination of correlations across various periods of time, investors can get a better understanding of the ways in which assets interact in various kinds of market conditions and modify their investment approaches accordingly. To understand asset relationships in more depth under diverse market conditions, we use time-varying correlations.The Philips Perron unit root test and the Augmented Dickey Fuller (ADF) test are used to examine a stationary process of the return series. Table 3 displays the outcomes of these tests.

Table 3: Unit Root Test Result

	GOLD	SILVER	NIFTY	INFLATION
ADF	-13.5843	-11.1825	-14.19547	-8.5508
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
PP	-13.5683	-12.0123	-11.212	-8.4630
	(0.0000)	(0.0000)	(0.0000)	(0.0000)

Source: Author's calculation

It indicates that, at the 1% level of significance, we can rule out the existence of a unit root, proving that the return series is a stationary process. To comprehend the time-varying correlation, we used the DCC-GARCH (1,1) model. The parameters and results of the diagnostic test are shown in Table (4). The time-varying correlation coefficients are depicted

	INFLATION		NIFTY		SILVER		GOLD	
Mean ϕ	0.420984	4.908	0.009970	3.183	0.005110	1.541	0.009048 3.443	
Variance ω	0.091497	3.037	1.235311	2.000	2.806908	3.566	1.191343	4.249
α	0.050252	1.521	0.038639	2.48	0.023085	1.231	0.011279	1.028
β	1.517157	8.053	1.654659	13.87	1.763432	14.57	1.842405	19.19
Model Fitness								
Ljung Box Q(5)	5.92535 [0.3135510]		11.2793 [0.0461158]		17.1256 [0.0042677]		4.90132 [0.4280412]	
Ljung Box Q(10)	10.4545 [0.4015651]		12.0952 [0.2787376]		19.1456 [0.0384515]		11.7484 [0.3022505]	
Ljung Box Q(20)	33.6315 [0.0287286]		22.1301 [0.3334934]		27.1694 [0.1305659]		17.6181 [0.6125468]	
Ljung Box Q^2 (5)	1.71381 [0.8871552]		1.00359 [0.9622756]		4.12088 [0.5321462]		3.49782 [0.6237177]	
Ljung Box Q^2 (10)	6.81594 [0.7426998]		1.66704 [0.9983139]		8.93264 [0.5385078]		7.57447 [0.6703238]	
Ljung Box Q^2 (20)	16.7805 [0.6671804]		6.75182 [0.9974231]		14.8147 [0.7869125]		9.81587 [0.9713891]	

Table 4: Empirical Results of GARCH and DCC GARCH Models

| DCC with correlation targeting	
$\rho_t^{INFLFSI}$	0.193422** (2.275) [0.0239]
ρ_t^{INFLFG}	0.109200* (1.940). [0.0549]
$\rho_t^{LNIFTLFSI}$	0.224944*** (2.842) [0.0049]
$\rho_t^{LNIFTLFG}$	-0.078599 (-0.9273) [0.3548]
$\rho_t^{LFGLFSI}$	0.711290*** (19.32) [0.0000]

Source: Author's calculation.
The t-values (), the values in [] provided in the section are P values, and the symbols ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

in Figure 2.The averages of the time-varying correlations for the three distinct time periods—the pre-crisis, crisis, and post-crisis periods—are shown in Table 5. The dynamic relationship between the

variables during these several temporal phases is thoroughly outlined in this table.

Figure 3: Visualization of Time-Varying Correlation Coefficients
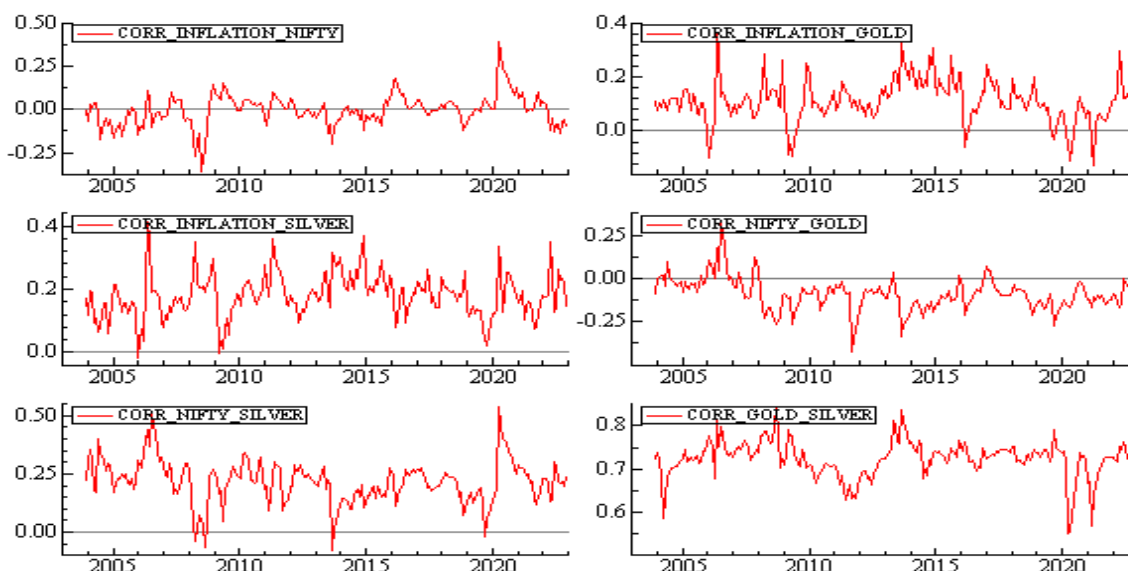
Table 5: Average of Time Varying Correlation

	GOLD-INFLATION	SILVER-INFLATION	GOLD-NIFTY	SILVER-NIFTY	NIFTY-INFLATION	GOLD-SILVER
Pre Crisis Period	0.100	0.146	0.009	0.279	-0.039	0.729
Crisis Period	0.115	0.198	-0.165	0.110	-0.08844	0.766
Post-Crisis Period	0.114	0.186	-0.113	0.206	0.013787	0.718

According to the DCC rho coefficient, showed in the table 4. There is a statistically significant positive correlation between inflation and silver as well as nifty and silver. Since there is a positive correlation between inflation and Silver, Silver may be able to protect against the value loss brought on by inflation. It means silver can be used as an inflation hedge. There is a positive correlation between Nifty and silver. This correlation may have an impact on investors since the diversification of a portfolio that already incorporates Nifty stocks may not be significantly increased by the inclusion of silver. Investors may need to look at alternative assets or industries that have a weaker relationship with the Nifty in order to diversify their portfolios. Compared to silver, which has high correlation, gold return and inflation have a weaker relationship. Moreover, it is statistically marginally significant at a level of 10%. The low positive correlations suggest that gold may have certain features that help it hedge against inflation, but it may not provide the greatest protection. From the plot of

correlation between inflation and gold, it is evident that for some of the period, it shows a negative correlation. The correlation is slightly higher during the crisis period than it is throughout the other periods, as per the table 5. However, the correlations show very little variation, which points to a persistent overall pattern throughout the various time periods.

Gold and the Nifty's returns are negatively correlated. It lacks statistical significance, though. The non-significant connection suggests that there is no meaningful or persistent relationship between gold and the Nifty index. The variations in gold prices and the Nifty index could not have always correlated during the time period under consideration. However, combining the two assets in a diversified investment portfolio could provide some advantages for diversification. The likelihood that the Nifty index and gold prices would fluctuate independently reduces the portfolio's exposure to the risks related to each asset. The correlation values fluctuate over time. The range of the correlation, from -0.4207 to 0.3243, illustrates how the relationship between gold and the Nifty have changed over time. There are several situations where the correlation is negative, as well as situations where it is positive, it is depicted in the plot if the correlation between gold and nifty. This exemplifies how the relationship between gold and the Nifty is dynamic and influenced by a number of factors, including monetary policy, sentiment among investors, and other global events. As per Table 5, it was highly negative during the period of the financial crisis of 2008. Thus, gold can be used as a hedge against market falls. Our finding is in line with the Creti, et al 2013. They found the evidence for considering gold as a safe-haven, as its negative correlations with stock returns and reduce in times of declining stock prices.

The calculated correlation coefficient between the returns on silver and gold is 0. 711290. These two assets are associated in a highly statistically significant manner (p value = 0.000). This means that macroeconomic factors and investor sentiment that impact one metal may also affect the other metal. The high positive correlation between silver and gold suggests that a portfolio of diversified investments that contains both silver and gold may not benefit as much from diversification. However, pair trading can be considered. The spread between the two series may be monitored by traders, and trades can be made when it deviates from its historical trend. When the gap widens by more beyond a certain level, a trader may simultaneously buy silver and sell gold. The spread is expected to gradually narrow, which might lead to benefits when the prices converge. We found insignificant positive rho value between Inflation and Nifty. Depending on how strong various channels are at work, the relationship between inflation and stock market prices may be either positive or negative.

During both the crisis and pre-crisis periods, it shows a negative correlation, whereas it is positive during the post-crisis period. Normally, the relation between Inflation and stock market is positive. There are two explanations for why inflation has a positive impact on stocks: The dividends would increase firstly if the economy were stimulated along with inflation. Small inflation is considered beneficial for the economy. Second, it lowers bond returns, which would increase demand for stocks. In the results, most of the time shows positive relation. However, it is negative when there is a financial crisis.

5. Conclusion

In this article, we looked at the portfolio and hedging capabilities of gold and silver in the Indian financial market. We extracted the time-varying interdependencies between the Nifty, inflation, gold, and silver in order to analyse this. Through research, several correlations between different financial assets have been discovered. Silver and inflation have a statistically significant positive relationship, suggesting that silver can act as an inflation hedge. Comparing to gold, silver is an excellent hedge against inflation. Additionally, there is a strong positive correlation between the Nifty index and silver, indicating that these two assets rise together. This finding implies that the diversification advantages of including silver in a portfolio that already contains Nifty stocks may not be significant. Gold has a lower association with inflation than silver does, but it still has a number of qualities that might make it a good inflation hedge. Although gold and the Nifty's returns have a negative correlation, it is not statistically significant, proving that there is no long-term relationship between the two. However, combining gold and the Nifty in a diversified portfolio may provide some benefits for diversification by reducing exposure to risks associated with each asset. The changing correlation throughout time between gold and the Nifty implies a dynamic connection influenced by a variety of factors. As market falls occur, it is found that gold is a safe-haven asset, which is supported by information from the 2008 financial crisis. Silver and gold may also not significantly increase the diversification of a portfolio that holds both metals due to their high correlations. However, to benefit from changes in their historical pattern, pair trading strategies might be used. There is minimal to no correlation between inflation and the Nifty, depending on the historical period. Although it sometimes has the opposite effect during financial crises, inflation frequently has a positive impact on stock market valuations. The relationship is advantageous since growing dividends and decreasing bond returns stimulate economic development. These statistics demonstrate the dynamic and intricate relationships between the financial markets, which are influenced by a wide range of macroeconomic factors and global events.

The findings of the research have major implications for hedging tactics and portfolio management in the Indian financial market. Although gold has characteristics that may make it an inflation hedge, there is no evidence of long-term importance in its link with the Nifty index. Still, there might be advantages in terms of lower risk when gold and the Nifty are combined in a diversified portfolio. Gold's importance as a safe-haven asset is highlighted by the dynamic nature of correlations, especially during market downturns, as seen by its performance during the 2008 financial crisis.

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